Predictors for postoperative oxygen therapy and postoperative mechanical ventilation need in children who underwent non-cardiac surgery under general anesthesia

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Background:

Postoperative oxygen therapy in children is not only related to postoperative hypoxemia but also related to other factors during anesthesia which has never been investigated. To identify predictors for postoperative oxygen therapy might reduce short term consequences of postoperative oxygen therapy such as length of hospital stay. The objectives of this study were to determine predictors for the need for postoperative oxygen devices and postoperative mechanical ventilation use among children undergoing non-cardiac surgery under general anesthesia.

Methods:

This was a cross sectional study of a prospective study of Oofuvong's regarding perioperative respiratory event in children. We recruited children aged < 15 years, ASA physical status I-III who scheduled for non-cardiac surgery and underwent general anesthesia between November 2012 and December 2013 at Songklanagarind Hospital. Demographic, surgical-related and anesthesia-related data were recorded. The association between oxygen devices and postoperative mechanical ventilation need and potential predictors were determined by Wilcoxon rank sum test and Chi-square test. The multivariate polytomous logistic regression analysis was performed to identify independent predictors of oxygen devices and mechanical ventilation need postoperatively. The relative risk ratios and 95% confidence interval (CI) were displayed and considered significantly if p-value were < 0.05.

Results:

We included 1334 children in the study. The incidences of postoperative oxygen devices and mechanical ventilation were 4.05% and 2.32%. Age group distributions were < 1 year (10.64%), 1-6 years (57.80%) and > 6 years (31.56%). The incidences of intraoperative and PACU respiratory events were 9.3% and 8.62%. Predictors for postoperative oxygen devices and mechanical ventilation needed were similar which were ASA physical status 3 ($p < 0.01$), low BMI ($< 15 \text{ kg/m}^2$, $p < 0.05$), thoracic surgery compared to eye surgery ($p < 0.01$), long anesthetic time ($p < 0.05$) and having intraoperative and PACU respiratory events ($p < 0.001$). Another predictor of oxygen devices was endotracheal intubation compared to face mask or LMA used ($p < 0.01$). Postoperative oxygen devices need was significantly associated with longer PACU time (median and IQR; 60 (50,80) in OD group vs 45 (35,60) in NO group, $p < 0.001$), longer days of hospitalization (median and IQR; 4 (2,3,9) in OD group vs 2 (1,3) in NO group, $p < 0.001$) and higher hospital cost (median and IQR; 22602.5 (15758,40978.5) in OD group vs 13861 (9924,23329) in NO group, $p < 0.001$).

Conclusions:

The common predictors of postoperative oxygen therapy needed were ASA physical status, longer anesthetic time and having perioperative respiratory events. To reduce perioperative respiratory events by closed monitoring and increased vigilance of anesthesiologist might decrease days of hospitalization and hospital charge related to postoperative oxygen therapy in pediatric anesthesia.

Table 2 Anesthesia-related risk and surgical-related risk of children who needed postoperative oxygen therapy and mechanical ventilation group compared with control

	NO group (1,249)	OD group (54)	MV group (31)	P-value
ASA physical status				< 0.001*
1	301 (24.1)	5 (9.3)	1 (3.2)	
2	844 (67.6)	26 (48.1)	10 (32.3)	
3	104 (8.3)	23 (42.6)	20 (64.5)	
Type of surgery				< 0.001*
Urology	189 (15.1)	6 (11.1)	2 (6.5)	
ENT	272 (21.8)	18 (33.3)	2 (6.5)	
Eye	309 (24.7)	2 (3.7)	4 (12.9)	
Thoracic	2 (0.2)	1 (1.9)	4 (12.9)	
Abdominal	69 (5.5)	12 (22.2)	11 (35.5)	
Orthopedic	152 (12.2)	6 (11.1)	2 (6.5)	
Cath lab	44 (3.5)	1 (1.9)	0 (0.0)	
Others	212 (17)	8 (14.8)	6 (19.4)	
Choice of anesthesia				0.536
General anesthesia only	980 (78.5)	40 (74.1)	24 (77.4)	
General anesthesia with epidural/caudal block	202 (16.2)	10 (18.5)	7 (22.6)	
General anesthesia with peripheral nerve block	67 (5.4)	4 (7.4)	0 (0)	
Technique of anesthesia				< 0.001*
Mask	110 (8.8)	0 (0)	0 (0)	
Laryngeal mask airway	408 (32.7)	5 (9.3)	2 (6.5)	
Total intravenous anesthesia	14 (1.1)	1 (1.9)	0 (0)	
Endotracheal tube intubation with inhalation technique	140 (11.2)	7 (13)	1 (3.2)	
Endotracheal tube intubation with balanced technique	577 (46.2)	41 (75.9)	28 (90.3)	
Induction agent				< 0.001*
Sevoflurane	540 (43.2)	10 (18.5)	4 (12.9)	
Propofol	621 (49.7)	39 (72.2)	22 (71)	
Thiopental	78 (6.2)	5 (9.3)	5 (16.1)	
Others	10 (0.8)	0 (0)	0 (0)	
Intubation agent				< 0.001*
Succinylcholine	59 (4.7)	5 (9.3)	3 (9.7)	
Non-depolarizing muscle relaxant	544 (43.6)	38 (70.4)	24 (77.1)	
Sevoflurane	68 (5.4)	1 (1.9)	1 (3.2)	
Propofol	92 (7.4)	2 (3.7)	0 (0)	
None	486 (38.9)	8 (14.8)	3 (9.7)	
Inhalation agent				0.654
Sevoflurane	1204 (96.4)	51 (94.4)	31 (100)	
Isoflurane	7 (0.6)	1 (1.9)	0 (0)	
Desflurane	7 (0.6)	1 (1.9)	0 (0)	
None	31 (2.5)	1 (1.9)	0 (0)	
Gas				0.918
No	1156 (92.6)	50 (92.6)	30 (96.8)	
N ₂ O	73 (5.8)	3 (5.6)	1 (3.2)	
100% O ₂	20 (1.6)	1 (1.9)	0 (0)	
Narcotic				0.007*
Intravenous fentanyl	1140 (91.3)	43 (79.6)	27 (87.1)	
Intravenous morphine	37 (3)	4 (7.4)	0 (0)	
Epidural/caudal fentanyl	35 (2.8)	2 (3.7)	2 (6.5)	
Epidural/caudal morphine	25 (2)	2 (3.7)	2 (6.5)	
None	12 (1)	0 (0)	0 (0)	
Duration of anesthesia (min) ^a	85 (60,120)	120 (85,168.8)	145 (88,267.57)	< 0.001 ^b
Respiratory events				< 0.001*
No	1069 (85.6)	9 (16.7)	17 (54.8)	
Intraoperative respiratory events	94 (7.5)	18 (33.3)	12 (38.7)	
Post-anesthetic care unit respiratory events	86 (6.9)	27 (50)	2 (6.5)	

* median(IQR), * p value < 0.05 by chi-square test, ** p value < 0.05 by Wilcoxon rank sum test
a = NO vs OD, b = NO vs MV

Table 3 Predictors for post-operative oxygen devices need and post-operative mechanical ventilation requirement performed by polytomous logistic regression

Predictor	Oxygen device		Mechanical ventilation	
	Relative risk ratio (95% CI)	P-value	Relative risk ratio (95% CI)	P-value
Age (year)				
< 1			4.52 (1.02,20.1)	0.01
1-6			1.30 (0.32,5.22)	
> 6			1	
Body mass index (kg/m ²)		0.01		0.01
5-14.9	2.24 (1.11,4.51)		2.95 (1.09,7.97)	
15-24.9	1		1	
25-60	1.22 (0.13,11.46)		9.31 (0.81,106.95)	
ASA physical status		0.001		0.01
1	1		1	
2	0.89 (0.29,2.73)		1.28 (0.14,11.67)	
3	5.32 (1.53,18.46)		10.82 (1.16,100.74)	
Type of surgery		0.01		< 0.001
Urology	12.93 (2.02,82.71)		1.26 (0.17,9.34)	
ENT	5.31 (1.07,26.38)		0.41 (0.06,2.78)	
Eye	1		1	
Thoracic	29.13 (1.02,828.87)		42.23 (3.89,457.96)	
Abdominal	16.09 (2.77,93.34)		2.75 (0.61,12.42)	
Orthopedic	19.07 (2.91,124.86)		1.64 (0.22,12.40)	
Cath lab	1.22 (0.08,17.82)		-	
Others	5.47 (0.96,31.27)		1.97 (0.42,9.23)	
Technique of anesthesia		0.01		
Mask/Laryngeal mask airway	1		-	
Endotracheal tube intubation	4.69 (1.36,16.17)		-	
Duration of anesthesia (min)	1.0052 (1.0008,1.0096)	0.001	1.0114 (1.0065,1.0163)	< 0.001
Respiratory		< 0.001		< 0.001
No	1		1	
Intraoperative respiratory events	19.51 (7.80,48.80)		8.60 (3.09,23.95)	
Post-anesthetic care unit respiratory events	46.61 (18.56,117.06)		2.13 (0.38,11.93)	

Table 4 Consequences of post-operative oxygen devices needed and post-operative mechanical ventilation group compared to control group

	NO group (1,249)	OD group (54)	MV group (31)	P-value
Duration in PACU (min) ^a	45 (35,60)	60 (50,80) ^b	47.5 (45,50) ^c	< 0.001 ^{b,c}
Postoperative complications				< 0.001 ^{**}
None	1207 (96.6)	43 (79.6)	19 (61.3)	
Miscellaneous	19 (1.5)	4 (7.4)	3 (9.7)	
Endocrine	11 (0.9)	3 (5.6)	4 (12.9)	
Hematology	6 (0.5)	2 (3.7)	0 (0)	
Central nervous system	4 (0.3)	1 (1.9)	1 (3.2)	
Others	2 (0.2)	1 (1.9)	4 (12.9)	
Day of hospitalization ^a	2 (1,3)	4 (2,3,9)	7 (5,5,12)	< 0.001 ^{b,c}
Hospital cost (Bath) ^a	13861 (9924,23329)	22602.5 (15758,40978.5)	57295 (33963.5,85578.5)	< 0.001 ^{b,c}

* p value < 0.05 by chi-square test, ** p value < 0.05 by Wilcoxon rank sum test,
* median(IQR), a = NO vs OD, b = NO vs MV, c = OD vs MV, n₁ = 53, n₂ = 6

Table 1 Demographic data of children who needed postoperative oxygen therapy and mechanical ventilation group compared with control group

	NO group(1,249)	OD group(54)	MV group (31)	P-value
Age (year)				< 0.001*
< 1	120 (9.6)	7 (13)	15 (48.4)	
1-6	725 (58)	34 (63)	12 (38.7)	
> 6	404 (32.3)	13 (24.1)	4 (12.9)	
Sex				0.182
Male	770 (61.6)	40 (74.1)	19 (61.3)	
Female	479 (38.4)	14 (25.9)	12 (38.7)	
Weight (kg) ^a	16.7 (12.24,27)	12.1 (8.3,18.3)	7.8 (4.2,13.4)	< 0.001 ^{b,c}
Height (cm) ^a	106.5 (88,125)	89.8 (76.5,110)	70 (55,98.5)	< 0.001 ^{b,c}
Body mass index (kg/m ²)				0.009*
5-14.9	531 (42.5)	30 (55.6)	22 (71)	
15-24.9	681 (54.5)	23 (42.6)	8 (25.8)	
25-60	37 (3)	1 (1.9)	1 (3.2)	
Upper respiratory tract infection				< 0.001*
No	1109 (88.8)	46 (85.2)	24 (77.4)	
Active	33 (2.6)	2 (3.7)	6 (19.4)	
Recent	107 (8.6)	6 (11.1)	1 (3.2)	
Parental smoking				0.944
Never	579 (46.4)	27 (50)	16 (51.6)	
Active	555 (44.5)	22 (40.7)	13 (41.9)	
Passive	114 (9.1)	5 (9.3)	2 (6.5)	
Snore				0.602
No	863 (69.1)	38 (70.4)	24 (77.4)	
Yes	386 (30.9)	16 (29.6)	7 (22.6)	
Income of parents (Bath)				0.411
<10,000	313 (25.1)	18 (33.3)	8 (25.8)	
10,000-50,000	785 (63.1)	33 (61.1)	21 (67.7)	
>50,000	147 (11.8)	3 (5.6)	2 (6.5)	

* median(IQR), * p value < 0.05 by chi-square test, ** p value < 0.05 by Wilcoxon rank sum test, a = NO vs OD, b = NO vs MV, c = OD vs MV